Amendments to the Claims

        This listing of claims will replace all prior

versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A semiconductor device operable in a THz
   spectral range, the device comprising a heterostructure
   configured to generate THz spectral range radiation in
   response to an external field applied across it, the
   heterostructure ~~including~~ comprising at least first and
   second semiconductor layers~~, the first and second layers
   being~~ made of materials providing a certain initial overlap
   between the valence band of the second layer material and the
   conduction band of the first layer material, and having a
   selected layout of the heterostructure layers providing a
   quantum mechanical coupling between an electron quantum well
   (EQW) in ~~the~~ said first layer and a hole quantum well (HQW)
   in ~~the~~ said second layer, ~~and providing an overlap between
   the valence band of the second layer and the conduction band
   of the first layer, a~~ said selected layout of the layers of
   the heterostructure ~~being selected so as to provide~~ defining
   a predetermined arrangement of a plurality of energy
   subbands and a predetermined dispersion of ~~energy subbands in
   the conduction band of the first layer and in the valence
   band of the second layer~~ these subbands including the
   substantially equidistant neighboring subbands to define a
   desired effective overlap between the energy subbands of said
   conduction and valence bands, thereby creating a condition of
   the multiple resonant radiative transitions substantially of
   the same frequency of the THz spectral range between the
   equidistant neighboring subbands, whereby an application of

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an external bias field across the first and second layers causes the THz spectral range radiation originating from said radiative transitions of non-equilibrium carriers between at least one of the following: neighboring energy subbands of the EQW, neighboring energy subbands of the HQW, and ground energy electron subbands of the EQW and ground energy hole subband of the HQW.

2. (Original) The device of Claim 1, wherein the first layer material is InAs-based and the second layer material is GaSb-based.

3. (Original) The device of Claim 2, wherein the thickness of each of the first and second layers is in a range of about 1-500nm.

4. (Original) The device of Claim 1, wherein the first and second layers are directly coupled to each other with no additional layer between them.

5. (Original) The device of Claim 1, wherein the heterostructure comprises a barrier layer between the first and second layers.

6. (Original) The device of Claim 5, wherein the barrier layer is based on AlSb.

7. (Original) The device of Claim 5, wherein the barrier layer has a thickness in a range of about 0.6-6 nm.

8. (Original) The device of Claim 1, wherein the heterostructure comprises first and second cladding layers enclosing the first and second layers therebetween, respectively.

9. (Original) The device of Claim 8, wherein the first and second cladding layers are selected from AlInAs-based and AlSb-based materials, respectively.

10. (Original) The device of Claim 5, wherein the heterostructure comprises first and second cladding layers

enclosing therebetween the first and second layers with the barrier layer between the first and second layers.

11. (Currently Amended) The device of Claim 1, comprising an electrode arrangement configured to ~~providing~~ provide electrical contacts to the first and second layers and thus ~~enabling~~ enable the application of said external bias field.

12. (Currently Amended) The device of Claim 1, comprising reflectors at opposite sides of the heterostructure, the device being thus configured and operable as a resonator cavity, said heterostructure serving ~~being operable~~ as an active medium of the cavity.

13. (Currently Amended) The device of Claim 1, wherein said selected layout of the layers of the heterostructure defines the predetermined dispersion of the energy subbands ~~is~~ characterized by a predetermined energy gap of ~~a~~ the THz spectral range between the ground energy subband ~~in~~ of the EQW and the ground energy subband of the HQW.

14. (Currently Amended) The device of Claim 13, wherein said predetermined dispersion of the energy subbands includes W-like dispersion ~~is such that energy~~ of both the ground hole subband of the HQW ~~without any coupling is higher than the energy~~ and of the ground electron subband of the EQW ~~without any coupling~~.

15. (Currently Amended) The device of Claim 13, wherein said predetermined dispersion of the energy subbands includes parabolic-like dispersion ~~is such that the energy~~ of the ground hole subband of the HQW ~~without any coupling is lower than the energy~~ and of the ground electron subband of the EQW ~~without any coupling~~.

16. (Currently Amended) The device of Claim 13, wherein said predetermined dispersion of the energy subbands is defined ~~controlled~~ by ~~altering~~ at least one of the following

parameters of the layout: thickness of at least one of the layers, chemical compound of the material of at least one of the layers, width and predetermined potential profile of at least one of the quantum wells.

17.   (Currently Amended) The device of Claim 16, wherein the heterostructure comprises a barrier layer between the first and second layers, ~~the parameters controlling the predetermined dispersion of the energy subbands include~~ the thickness and chemical compound of the material of ~~a~~ said barrier layer ~~arranged between the first and second layers~~ being selected to provide the substantially equidistant neighboring energy subbands.

18.   (Currently Amended) The device of Claim 16, wherein the heterostructure comprises first and second cladding layers enclosing said first and second layers therebetween, respectively, ~~the parameters controlling the predetermined dispersion of the energy subband include~~ the thickness and chemical compound of the material of the cladding layers ~~enclosing the first and second layers therebetween~~ being selected to provide the substantially equidistant neighboring energy subbands.

19.   (Currently Amended) The device of Claim 16, wherein a material composition of at least one of the first and second layers is spatially inhomogeneous in a direction normal to the respective layer, thereby providing ~~the~~ a predetermined inhomogeneous potential profile of the respective quantum well.

20.   (Currently Amended) The device of Claim 1, wherein said multiple THz ~~radiation is enhanced by a resonance condition of the~~ radiative transitions include the transitions between ~~at least one of following:~~ the different neighboring subbands within the EQW, the different neighboring subbands within the

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HQW, and the ~~different neighboring~~ground electron subbands~~s~~ of the EQW and ground hole subband of the HQW.

21. (Currently Amended) The device of Claim ~~20~~1, wherein said multiple THz ~~resonance condition is further enhanced by the~~ radiative transitions include the ~~—~~transitions between the ground electron subband of the EQW and the ground hole subband of the HQW.

22. (Currently Amended) The device of Claim ~~20~~1, wherein said selected layout of the layers defines the plurality of substantially equidistant neighboring energy subbands in at least one of the quantum well selected from the EQW and HQW ~~are substantially equidistant~~, thereby causing said resonance condition of the multiple radiative transitions between ~~the~~a few of the substantially equidistant neighboring energy subbands of the respective quantum well.

23. (Currently Amended) The device of Claim ~~20~~1, wherein said ~~the~~ substantially equidistant neighboring energy subbands include neighboring energy subbands within each of the EQW and HQW, ~~are all substantially equidistant within each quantum well and~~ and neighboring ~~a distance between~~ the ground energy electron subband~~s~~ of the EQW and the ground hole subband of the HQW ~~is equal to the distance between the neighboring energy subbands of the EQW and HQW~~.

24. (Currently Amended) The device of Claim 19, wherein the predetermined inhomogeneous potential profile of at least one quantum well selected from the EQW and HQW is substantially semi-parabolic, thereby providing substantial~~ly~~ equidistance in between a ~~plurality~~few of the neighboring energy subbands from ~~of~~ the neighboring energy subbands in the respective quantum well and the neighboring ground electron subband of the EQW and ground hole subband of the HQW for causing ~~a~~the

resonance condition of the multiple radiative transitions ~~between the subbands~~.

25. (Currently Amended) The device of Claim ~~19~~1, wherein the predetermined potential profile of at least one quantum well selected from the EQW and HQW is substantially step-like, while a few of the neighboring energy subbands ~~from the neighboring energy subbands~~ in ~~the~~ this ~~respective~~ quantum well and the neighboring ground electron subband~~s~~ of the EQW and ground hole subband of the HQW are substantially equidistant for causing ~~a~~ the resonance condition of the multiple radiative transitions ~~between the subbands~~.

26. (Currently Amended) The device of Claim ~~19~~1, wherein the predetermined potential profiles of one of the EQW and HQW~~Q~~ ~~include~~ is substantially semi-parabolic and the predetermined potential profiles of the other of said EQW and HQW is step-like ~~profiles~~.

27. (Currently Amended) The device of Claim 19, wherein said selected layout of the layers of the heterostructure defines the dispersion of the energy subbands ~~is~~ such that excited subbands of the EQW define a nearly parabolic band-structure, and the ground electron subband~~s~~ of the EQW and ground hole subband of the HQW define a W-like dispersion.

28. (Cancelled)

29. (Currently Amended) The device of Claim 20, wherein said arrangement of subbands provides the resonance condition ~~is achieved~~ for said neighboring subbands of the EQW within the entire ~~certain~~ range of variation of a wave-vector.

30. (Currently Amended) The device of Claim 29, wherein the arrangement of subbands defines a majority of said neighboring subbands of the EQW ~~are~~ being parallel in a subband dispersion plot.

31.   (Currently Amended) The device of Claim 29, wherein the multiple resonant transitions include ~~resonance condition is further enhanced by~~ the radiative transition between the ground electron subband of the EQW and the ground hole subband of the HQW.

32.   (Currently Amended) The device of Claims ~~31~~21 wherein said selected layout provides for the radiative transition between the ground electron subband of the EQW and the ground hole subband of the HQW either at a zero value of ~~occurs when the~~ a wave-vector ~~equals zero~~ for parabolic-like dispersion of said ground subbands or at non-zero value of an electron wave-vector for W-like dispersion of said ground subbands.

33.   (Currently Amended) The device of Claim ~~29,~~ 32 wherein said selected layout provides the ~~resonance~~ resonant arrangement of the subbands ~~condition is further enhanced by~~ for the radiative transition between at least one of the following: (i) the ground electron subband of the EQW and the ground hole subband of the HQW at a certain non-zero magnitude of the in plane wave-vector and (ii) the ground hole subband of the HQW and its neighboring hole subband at a certain non-zero magnitude of the in plane wave-vector providing   that an energy gap corresponding to these transitions is minimal.

34.   (Currently Amended) A semiconductor device operable in THz spectral range, the device comprising a heterostructure including at least first and second semiconductor layers and ~~al~~ an electrodes' arrangement providing electrical contacts to the ~~first and second layers~~heterostructure to apply a bias field across ~~them~~the heterostructure, wherein
   - the first and second layers are made of materials ~~providing a quantum mechanical coupling between an electron quantum~~

~~well (EQW) in the first layer and a hole quantum well (HQW) in the second layer, and~~ providing ~~an~~ certain initial overlap between the valence band of the material of the second layer and the conduction band of the material of the first layer,

- the heterostructure has a selected layout of the layers ~~of the heterostructure~~ providing a quantum mechanical coupling between an electron quantum well (EQW) in the first layer and a hole quantum well (HQW) in the second layer, ~~and~~ where potential profiles of the EQW and HQW are selected ~~so as~~ to ~~provide~~ define an arrangement of energy subbands of a predetermined dispersion ~~of energy subbands~~ in at least one of the conduction band of the first layer and ~~in~~ the valence band of the second layer to define a desired effective overlap between the energy subbands, the arrangement of energy subbands creating ~~of said conduction and valence bands, said predetermined dispersion resulting in that the application of the external bias field across the first and second layers causes the THz spectral range radiation originating from~~ a ~~resonance~~ condition of the multiple resonant radiative transitions of non-equilibrium carriers substantially of the same frequency of the THz spectral range between at least some of the following: the neighboring energy subbands of the EQW, the neighboring energy subbands of the HQW, and the ground energy electron subband~~s~~ of the EQW and the ground energy hole subband HQW.

35.   (Withdrawn)   A   method   of   fabricating   the semiconductor device of Claim 1 operable in a THz spectral range, the method comprising forming a heterostructure from selected layers

wherein the layers include at least first and second semiconductor layers made of materials providing a quantum mechanical coupling between an electron quantum well (EQW) in the first layer and a hole quantum well (HQW) in the second layer and providing an overlap between the valence band of the material of the second layer and the conduction band of the material of the first layer,

a layout of the layers of the heterostructure is selected so as to provide a predetermined dispersion of energy subbands in the conduction band of the first layer and the valence band of the second layer to define a desired effective overlap between the energy subbands of said conduction and valence bands,

thereby enabling generation of THz radiation originating from radiative transitions of non-equilibrium carriers between at least one of the following: neighboring energy subbands of the EQW, neighboring energy subbands of the HQW, and ground energy subbands of the EQW and HQW.

36.   (Withdrawn) The method of Claim 35, wherein said predetermined dispersion of the energy subbands is such that energy of the ground hole subband of the HQW without any coupling is higher than the energy of the ground electron subband of the EQW without any coupling.

37.   (Withdrawn) The method of Claim 35, wherein said predetermined dispersion of the energy subbands is such that the energy of the ground hole subband of the HQW without any coupling is lower than the energy of the ground electron subband of the EQW without any coupling.

38.   (Withdrawn) The method of Claim 35, wherein said predetermined dispersion of the energy subbands is provided by altering at least one of the following parameters: thickness of at least one of the layers,

chemical compound of the material of at least one of the layers, width and predetermined potential profile of at least one of the quantum wells.

39.   (Withdrawn) The method of Claim 38, wherein the parameters controlling the predetermined dispersion of the energy subbands include the thickness and chemical compound of the material of a barrier layer arranged between the first and second layers.

40.   (Withdrawn) The method of Claim 38, wherein the parameters controlling the predetermined dispersion of the energy subband include the thickness and chemical compound of the material of cladding layers enclosing the first and second layers therebetween.

41.   (Withdrawn) The method of Claim 38, comprising selecting a material composition of at least one of the first and second layers to be with spatially inhomogeneous in a direction normal to the respective layer, thereby providing the predetermined potential profile of the respective quantum well.

42.   (Withdrawn) The method of Claim 35, comprising selecting the layers' layout so as to enable creation of a resonance condition of the radiative transitions between at least one of the following: the different neighboring subbands within the EQW, the different neighboring subbands within the HQW, and the different neighboring subbands of the HQW and EQW, thereby enhancing the THz radiation.

43.   (Withdrawn) The method of Claim 42, wherein said resonance condition is further enhanced by the radiative transitions between the ground subband of the EQW and the ground subband of the HQW.

44.   (Withdrawn) The method of Claim 42, wherein the layers' layout is selected such that a plurality of the neighboring energy subbands in at least one of the quantum well selected from the EQW and HQW are substantially equidistant, thereby causing said resonance condition of the radiative transitions between the neighboring energy subbands of the respective quantum well.

45.   (Withdrawn) The method of Claim 42, wherein the layers' layout is selected such that the neighboring energy subbands of the EQW and HQW are all substantially equidistant within each quantum well and a distance between the ground energy subbands of the EQW and HQW is equal to the distance between the neighboring energy subbands of the EQW and HQW.

46.   (Withdrawn)   The method of Claim 41, wherein the predetermined potential profile of at least one quantum well selected from the EQW and HQW is substantially semi-parabolic, thereby providing substantially equidistance in between a plurality of the neighboring energy subbands in the respective quantum well for causing a resonance condition of the radiative transitions between the subbands.

47.   (Withdrawn) The method of Claim 41, wherein the predetermined potential profile of at least one quantum well selected from the EQW and HQW is substantially step-like, while a plurality of the neighboring energy subbands in the respective quantum well are substantially equidistant for causing a resonance condition of the radiative transitions between the subbands.

48.   (Withdrawn) The device of Claim 41, wherein the predetermined potential profiles of the EQW and HWQ

include substantially semi-parabolic and step-like profiles.

49.   (Withdrawn) The method of Claim 42, wherein gain provided by the resonance condition is a certain times higher than a gain in the non resonant condition, said certain number of times being equal to the number of the resonant neighboring subbands.

50.   (Withdrawn) The method of Claim 42, wherein said resonance condition is achieved for said neighboring subbands of the EQW within the entire range of variation of a wave-vector.

51.   (Withdrawn) The method of Claim 50, wherein said neighboring subbands of the EQW are parallel in a subband dispersion plot.

52.   (Withdrawn) The method of Claim 50, wherein said resonance condition is further enhanced by the radiative transition between the ground subband of the EQW and the ground subband of the HQW.

53.   (Withdrawn) The method of Claim 50, wherein the radiative transition occurs when the wave-vector equals zero.

54.   (Withdrawn) The method of Claim 50, wherein said resonance condition is further enhanced by the radiative transition between the ground subband of the HQW and its neighboring subband at a predetermined magnitude of the wave-vector to provide that an energy gap between the ground subband of the HQW and its neighboring subband is minimal.

55.   (Withdrawn)   A method of fabricating the semiconductor device of Claim 1operable in a THz spectral range, the method comprising forming a heterostructure from selected layers

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wherein the layers include at least first and second semiconductor layers made of materials providing a quantum mechanical coupling between an electron quantum well (EQW) in the first layer and a hole quantum well (HQW) in the second layer and providing an overlap between the valence band of the second layer and the conduction band of the first layer, a layout of the layers of the heterostructure is selected so as to provide a predetermined dispersion of energy subbands in the conduction band of the first layer and the valence band of the second layer to define a desired effective overlap between the energy subbands of said conduction and valence bands, the predetermined dispersion being such that application of a bias field across the first and second layers results in generation of THz radiation originating from a resonance condition of radiative transitions of non-equilibrium carriers between the neighboring energy subbands of the EQW, the neighboring energy subbands of the HQW, and the ground energy subbands of the EQW and HQW.

56.   (Withdrawn)   The method   of fabricating the semiconductor device of Claim 1 operable in a THz spectral range, the method providing for improved temperature characteristics of the device and comprising forming a heterostructure from selected layers wherein the layers include at least first and second semiconductor layers made of materials providing a quantum mechanical coupling between an electron quantum well (EQW) in the first layer and a hole quantum well (HQW) in the second layer and providing an overlap between the valence band of the second layer and the conduction band of the first layer, a layout of the layers of the heterostructure is selected so as to provide a predetermined dispersion of energy subbands in the conduction band of the first layer and the valence band of the

second layer to define a desired effective overlap between the energy subbands of said conduction and valence bands, the predetermined dispersion being such that application of a bias field across the first and second layers results in generation of THz radiation originating from a resonance condition of radiative transitions of non-equilibrium carriers between the substantially parallel and equidistant neighboring energy subbands of the EQW, the neighboring energy subbands of the HQW, and the ground energy subbands of the EQW and HQW.

57.   (Withdrawn) The method of fabricating the semiconductor device of claim 1 operable in a THz spectral range, the method providing for improved radiative characteristics of the device and comprising forming a heterostructure from selected layers

wherein the layers include at least first and second semiconductor layers made of materials providing a quantum mechanical coupling between an electron quantum well (EQW) in the first layer and a hole quantum well (HQW) in the second layer and providing an overlap between the valence band of the second layer and the conduction band of the first layer,

a layout of the layers of the heterostructure is selected so as to provide a predetermined dispersion of energy subbands in the conduction band of the first layer and the valence band of the second layer to define a desired effective overlap between the energy subbands of said conduction and valence bands, the predetermined dispersion being such that application of a bias field across the first and second layers results in generation of THz radiation originating from a resonance condition of radiative transitions of non-equilibrium carriers between the substantially parallel and equidistant neighboring energy subbands of the EQW, the neighboring energy subbands of the HQW, and the ground energy subbands of the EQW and HQW.

58.   (Withdrawn) The method of Claim 56, providing for suppressing Auger recombination as a result of effective screening of Coulomb interaction.

59.   (Withdrawn) The system of Claim 56, providing for suppressing optical phonon scattering for a radiated frequency lower than that of optical phonons.

60. (New) The device of Claim 1, wherein said THz spectral range includes a spectral range from 0.1 through 20 THz.

61. (New) The device of Claim 1, wherein the frequency of the radiative transitions is lower than a frequency of optical phonons.

62. (New) A semiconductor device operable in a THz spectral range, the device comprising a heterostructure configured to generate the THz spectral range radiation in response to an external bias field applied across it, the heterostructure comprising at least first and second semiconductor layers made of materials providing a certain initial overlap between the valence band of the second layer material and the conduction band of the first layer material, the heterostructure having a selected layout of the layers providing a quantum mechanical coupling between an electron quantum well (EQW) in the first layer and a hole quantum well (HQW) in the second layer, and providing a predetermined potential profile of at least one of the quantum wells defined by an arrangement of a ground electron energy subband in the EQW and a hole energy subband in the HQW, thereby defining a desired effective overlap between the energy subbands of said conduction and valence bands and creating a condition of radiative transitions of the THz spectral range between said ground subbands.

63. (New) The device of Claim 62, wherein said selected layout provides for the radiative transition between the ground electron subband of the EQW and the ground hole subband of the

HQW either at a zero value of a wave-vector for parabolic-like dispersion of said ground subbands or at non-zero value of an electron wave-vector for W-like dispersion of said ground subbands.